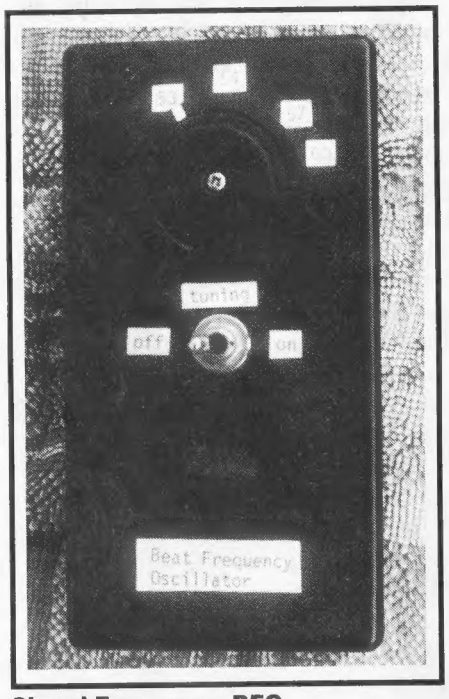
■ Receivers

Receive SSB on Your Shortwave AM Radio

(Hear amateur activity for under $15!)

Peter Parker VK1PK explains how you can listen to SSB signals on an AM radio.*



Signal Frequency BFO.

Project Level: Beginner.
Cost: Very Low.
Parts Procurement: Easy.

Introduction

The days when you could listen to amateurs on a simple shortwave AM receiver are with us again, thanks to the development of this one-transistor, frequency-agile signal frequency beat frequency oscillator. When teamed up with a low-cost AM set covering 3.5 and 7 MHz, this device provides effective reception of local eighty and forty metre SSB transmissions.

It is an ideal project for aspiring amateurs, as it allows them to monitor amateur activity. Its usefulness, low cost, and ease of construction would make it a good group project for schools, radio clubs or amateur theory classes.

The device is a miniature transmitter. It provides a steady carrier signal to the receiver to replace that suppressed within the transmitter (refer to any radio theory book for a more detailed explanation). It is the ultimate in simplicity, employing but eight components. The unit costs approximately ten dollars to build from all-new parts, and requires no alignment or connections to the receiver. Anyone with basic soldering skills can construct this project, and have it working first time.

Though receivers covering the short wave bands are no longer in every home, suitable sets can be picked up cheaply at garage sales and swap meets. Tuning the medium wave and one or two short wave bands, their performance is lacking in many respects. Nevertheless, they work better than might be expected when used with this circuit. The reasons for this are given later.

Circuit Description

This unit is a one transistor 3.5 MHz RF oscillator whose frequency can be varied (Fig 1). As mentioned before, it replaces the carrier in the receiver that was suppressed during the transmitter's SSB generation process.

A 3.58 MHz ceramic resonator sets the oscillator frequency. This two-dollar component is similar to a crystal. Its main advantage is that it can be shifted over a 100 kHz frequency range by connecting a variable capacitor in series with it. While the frequency stability is somewhat inferior to that of a crystal, it is still acceptable for stable SSB reception.

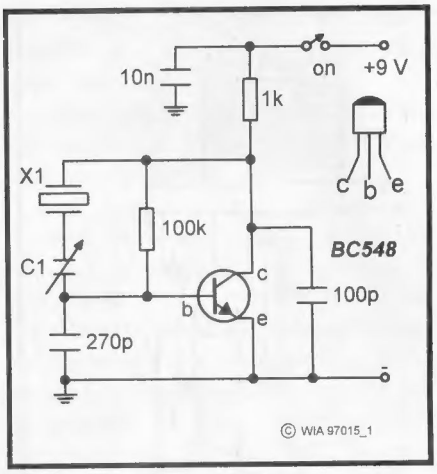


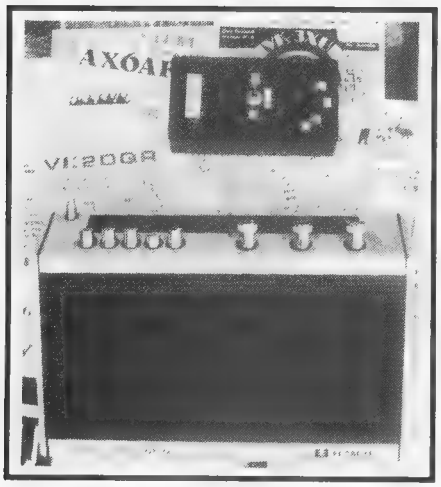
Figure 1 – Signal Frequency BFO schematic diagram. X1 is a 3.56 MHz ceramic resonator. C1 is a 60/160 pF variable capacitor with both sections connected in parallel.

Because the BFO operates directly on the received frequency, many of the limitations of low cost AM receivers (such as frequency drift, coarse frequency readout, hand-capacity and difficulty of tuning) are either eliminated or made less apparent. This is because the tuning in of SSB transmissions is effectively performed by a stable, easy to tune BFO, rather than the unstable free-running coarse-tuning local oscillator within the receiver. The latter would have been the case had a conventional 455 kHz fixed-frequency BFO been employed.

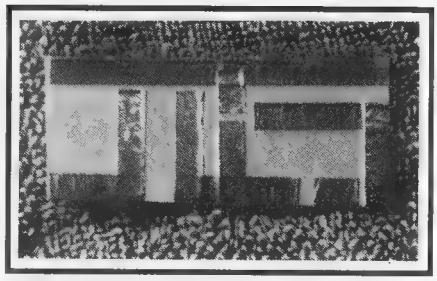
The circuit shown covers the popular 3.525 – 3.625 MHz frequency range. This permits reception of CW and SSB activity, WIA Divisional Broadcasts and Morse practice transmissions. The second harmonic of this range covers the 7.050 to 7.250 MHz segment of forty metres, while the fourth might be useable for twenty metre reception.

Construction

Virtually any construction method may be used to assemble the BFO. However, large stray capacitances must be avoided if the full tuning coverage is to be obtained. Several prototypes were built. The one in the photos uses a conventional single-sided etched printed circuit board. However, many other techniques are quicker, simpler and work just as well.



Signal Frequency BFO with typical AM short wave receiver.



Completed circuit board.

A method used by the author is to make a circuit board from a piece of cardboard (or plastic) and 5 mm-wide self-adhesive copper foil. This copper foil is sold on rolls at stained glass craft shops. Its adhesive is strong enough to withstand the heat from a soldering iron. Pieces of this tape are placed on a piece of cardboard (see photo). Where a bend is required, use two overlapping pieces.

Components are then soldered straight to the foil; use the schematic diagram and the photo for guidance. Areas where two pieces of tape overlap are soldered over to ensure a good connection. While the pictures depict the use of a piece of plastic for the board, this is not recommended as it tends to bend under heat. Instead, a piece of fairly rigid cardboard (eg from the side of an old cardboard box) is suggested. A blob of Blutak™ or similar may be used to mount it inside the case.

Full frequency coverage will only be obtained if leads are kept short. Those to the ceramic resonator and variable capacitor are particularly critical. Whereas most RF projects are built in metal cases to provide shielding, the BFO's operation depends on there being a lack of shielding between it and the receiver. Thus either a plastic or wooden box is recommended.

Testing/Operation

To verify BFO operation, your AM short wave set is required. Position the receiver near the BFO, and tune it across the 3.5 – 4 or 7 – 8 MHz frequency range.

At a certain point on the dial, the receiver will go quiet; all normal background noise will be silenced. Switching off the BFO will restore the normal band noise, while adjusting the BFO's **Tune** control will move the "silence" to a different frequency. If the BFO passes these two checks, you know that it works.

Now switch off the BFO, attach a piece of wire (preferably outdoors) to the receiver's telescopic antenna, and tune in a strong SSB signal for maximum volume. Assuming the received signal is within the BFO's tuning range, it will be possible to resolve the signal by correctly adjusting the BFO. Place the BFO near the receiver, and adjust the BFO's tune control until the receiver quietens. Move the BFO away from the set, and adjust it carefully until the SSB signal is intelligible. Note that this setting is critical; the BFO's frequency must be equal to that of the transmitter's suppressed carrier.

While at first this process is somewhat fiddly, it becomes easier with practice. For optimum results, experiment with the physical distance between the BFO and the receiver; weaker signals require less signal from the BFO (ie a greater separation). However, it should be possible to find a compromise position for the BFO where reception from all stations is satisfactory.

Conclusion

A novel device to allow the reception of amateur signals on domestic AM-only short wave receivers has been described. It is cheap, very simple to build, and can be expected to work first time. It fills a definite need amongst potential amateurs, and has the advantage of being expandable to a direct conversion receiver or CW/DSB transmitter or transceiver as interest develops.

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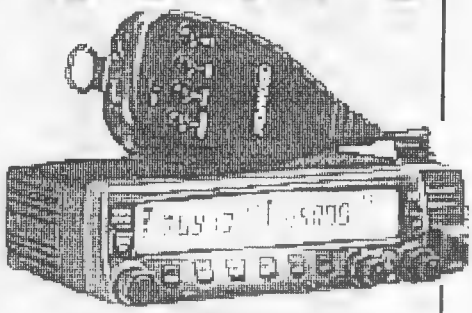

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TM-733A prize kindly donated by Kenwood Electronics Australia P/L, PO Box 504, Homebush 2140. Ph: (02) 9746 1888. Fax: (02) 9746 1509.

Obtaining ceramic resonators

The 3.58 MHz ceramic resonator used in the prototype was purchased over the counter from RS Components (catalogue no. 656-170). RS has outlets in most capital cities. The Melbourne supplier Vorlac has also advertised ceramic resonators. Note, however, that there are variations between different brands of resonator, and you may need to experiment with component values. Full details are provided in the parts list.

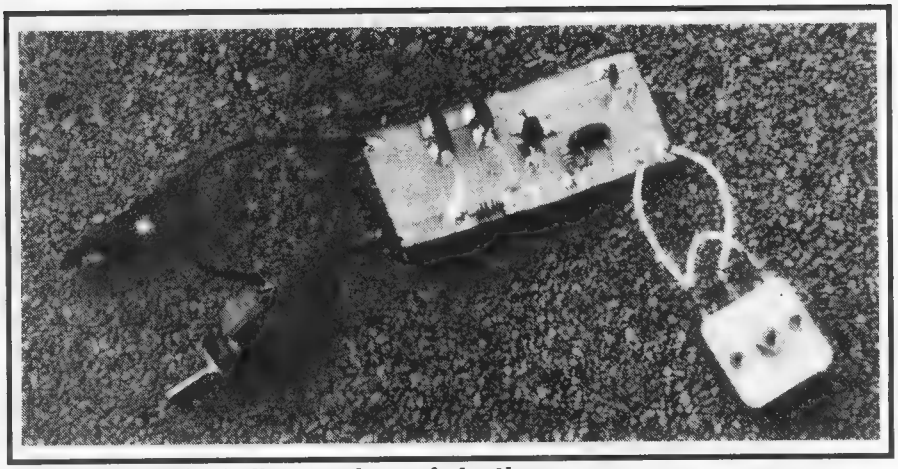
To assist those unable to obtain ceramic resonators for themselves, the author is able to supply free ceramic resonators to *Amateur Radio* readers on receipt of a stamped, self-addressed envelope sent to the address at the end of this article. Note that this offer is only valid for six months after the publication of this article, and for the first fifty people who respond.

Parts List

1 1 kilohm resistor
1 100 kilohm resistor
1 100 pF disc ceramic capacitor (See Notes 1 and 2)
1 270 pF (or 15 pF) disc ceramic capacitor (See Notes 1 and 2)
1 0.01 µF (10 nF) disc ceramic capacitor
1 60/160 pF transistor radio variable capacitor
1 3.58 MHz ceramic resonator (see shaded panel)
1 BC548 NPN transistor
1 SPST switch
Case, wire, solder, 9 volt battery snap, etc.

Notes:

1. These values provided a 3.525-3.625 MHz pulling range with the blue coloured ceramic resonators (as supplied by RS Components). If using one of the yellow ceramic resonators (as stocked by Vorlac), replace the 270 pF capacitor with one for 15 pF. This will provide a tuning range of about 3.550 – 3.610 MHz. Coverage down to 3.500 MHz is available by raising the value of the 15 pF capacitor. However, this will be at the expense of frequencies at the top of the range.



Completed BFO – built on a piece of plastic.

2. The use of polystyrene capacitors will improve the stability of the BFO, and would be desirable if the BFO is to be used for 20 metre reception. For the lower bands (particularly 80 metres), the disc ceramic capacitors specified are more than stable enough.

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QSP News

JOTA Balloon Launch

The JOTA Balloon Launch is a joint venture between the Scout Radio and Electronics Service Unit (Victoria) and the Eastern and Mountain Districts Radio Club Inc.

Change of Launch Time

The time of the Balloon Launch has been changed to provide better utilisation by the Scouts at JOTA (the 11.00 am launch would have been a bit early for many stations). This new time will also assist the re-transmission of the JOTA opening broadcast at 2.00 pm EST (04.00 hrs UTC).

The new launch time is 1.00 pm EST (03.00 hrs UTC) on Saturday, 18 October 1997.

Slow Scan TV on board the JOTA Balloon

The Balloon will carry a Slow Scan TV Transmitter along with the other advertised payload.

Balloon slow-scan telemetry is in monochrome using the Robot 36 mode. This can be received using the public domain JV-Fax software and a fairly cheap and simple "Hamcom" interface.

The beacon frequency will be 145.700 MHz, which is the frequency of the ARDF homing beacon.

Transmission mode will be FM. Output power will be 100 mW continuous which will increase to approx one watt for the data bursts.

There will be a four-channel cross band repeater which will operate on the following frequencies at approximately 100 mW per channel:

Chan	Uplink	Downlink	Usage
1	432.900	145.300	JOTA Traffic
2	432.925	145.325	JOTA Traffic
3	432.950	145.350	JOTA Traffic
4	432.975	145.375	General Traffic

Flight Details

The place of launch will be confirmed 24 hours before the launch and will be either the Police Paddocks near Dandenong (southerly winds), Geelong (westerly winds), or Bendigo (northerly winds).

Anticipated coverage when at peak altitude will be NSW (VK2), VIC (VK3), SA (VK5), and TAS (VK7). Line of sight coverage to sea level flat terrain will be approximately 500 km at 20 km altitude, and 350 km at 10 km altitude. Higher sites may extend the range up to a further 2-300 km. Antenna polarisation will be vertical, and the estimated flight time is three hours.

The mode of transmission will be FM in all cases, with FM voice telemetry, 1200 baud packet, and SSTV sent once every two minutes.

Further details may be obtained from the Scout Radio Electronics Service Unit, PO Box 311, Box Hill VIC 3128, or by contacting Philip Adams on 03 9438 3013 (AH) or 03 9262 1073 (BH).